How phylogeny and ecological adaptation describe variation in ophiuroid (Echinodermata: Ophiuroidea) vertebrae

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The arms in brittle stars are supported by a series of articulated vertebrae, allowing a wide range of motion, important for feeding and locomotion. This study provides a 3D geometric morphometric investigation of vertebral shape variation in relation to different functional and ecological aspects of ophiuroid lifestyles. Six segments within one arm from 12 species representing prehensile ophiuroids (with arms that can be wrapped around objects) and non-prehensile behaviors, were CT scanned. The 3D shape variation of the vertebrae was analysed, using 37 landmarks on each vertebra. After a Generalized Procrustes Analysis, a principal component analysis was done on the variance-covariance matrix of the obtained Procrustes coordinates to check the distribution of the species within the morphospace. A PERMANOVA was performed on the PC scores for all vertebrae to test for differences between species, between functional lifestyles (prehensile and non-prehensile species), and between ecological lifestyles (epizoic, endozoic, epiphytic, or free-living). Phylogenetic MANOVA and phylogenetic signal analysis were done to test whether functionality groups significantly differ after controlling for phylogeny and to explore the phylogenetic signal from a set of quantitative traits. The PERMANOVA indicated a significant difference in vertebral morphology between species and between lifestyles. The principal component analysis showed that prehensile species are most distinct from non-prehensile ones in the morphology of their articular structure and vertebral projection. The Phylogenetic MANOVA and phylogenetic signal analysis revealed that characteristics belonging to the aboral and lateral processes on vertebrae are necessary for phylogenetic interpretations, while dorsal and central articular structures probably have limited taxonomic value, as they may show adaptations to functional/ecological lifestyles.

Functional Morphology